1998. The Journal of Arachnology 26:385–388

RESEARCH NOTE

A DESCRIPTION OF AN UNUSUAL DOME WEB OCCUPIED BY EGG-CARRYING *HOLOCNEMUS PLUCHEI* (ARANEAE, PHOLCIDAE)

Spiders use silk to construct prey-capture webs, protective tubes and retreats, and egg sacs (reviewed in Nentwig & Heimer 1987). *Holocnemus pluchei* (Scopoli 1763) build irregular, often curved prey-capture sheets, and, like other pholcids, hold their eggs in a loose bundle in their chelicerae. Egg-carrying *H. pluchei* are found inside unusual dome-shaped webs that are easily distinguishable from the normal prey-capture web. Dome webs are generally spherical, completely surrounding the female and her eggs, and attached to structures such as buildings or the stiff inner branches of bushes. After the eggs hatch, the female leaves the dome. Spiderlings remain in the dome until their first molt. After molting, they disperse and either construct a sheet web or join the webs of other spiders, where they live together on the same sheet (Jakob 1991; unpubl. data). Here we describe dome webs in the field, including the presence of associated spiders outside of the domes, and the responses of spiders in-and-near dome webs to the vibration of a tuning fork, which generally elicits a prey-capture response from *H. pluchei* spiders on prey-capture sheets (Jakob 1991).

H. pluchei spiders are abundant in the Central Valley of California, and are commonly found in bushes, especially junipers (*Juniperus* sp.), and around human habitation. Although domes can be found deep within juniper bushes, that location makes them difficult to study. Therefore, we focused on dome webs found under an overhanging outdoor ceiling, approximately 2 m high, of Briggs Hall at the University of California at Davis. Observations were made on 16 and 17 August 1995.

We selected 24 dome webs for study. Nineteen contained a female with an egg sac in her chelicerae and five held a female surrounded by recent hatchlings (first instar spiderlings). Each web was numbered with masking tape adjacent to the web. Dome diameters were measured with a 10 cm ruler. Activity of females in the domes and of associated spiders was noted before and after the application of a tuning fork to the web. Behavior patterns noted were: approaching or wrapping the tuning fork, considered to be predatory behaviors; bouncing, a rapid up-and-down movement which has been shown to be an anti-predator response (Jackson et al. 1993); or no response. Webs were revisited the next day.

Domes averaged 5.04 cm in diameter (SE = 1.33) (Fig. 1). Nineteen were on the ceiling and five were in the corner formed by the ceiling and the wall. Fifteen were complete domes with no damage; nine had small holes in the side. Domes were composed of fine silken strands, with no apparent pattern in their arrangement. Strands were occasionally clumped into small balls on the surface of the dome. We saw no viscid balls, as has been noted in another pholcid (Briceño 1985).

There was at least one conspecific within 15 cm of 71% of females in web domes. These associated spiders were not on prey-capture webs, but were either resting directly on the outside of the dome, on a few silk threads attached to the building, or on the concrete overhang to which the dome was attached. The nearest groups of prey-capture webs were on bushes at least 10 m away from the domes described here. We have never seen spiders associated in the same way with the sheet webs used in prey capture; spiders near sheet webs are either in a web themselves or are moving rapidly through the vegetation. We identified classified spiders as mature males, mature females, medium juveniles (probably 4th instar) and small juveniles (2nd or 3rd instar) (representative measurements of size classes are given in Jakob 1994). The most common associ-

Figure 1.—Female *Holocnemus pluchei* and eggs, surrounding by a dome web.

ates were males (Table 1). On day 1, most females with eggs were accompanied by at least one male (14 of 19), but only one female with hatchlings was accompanied by a male; this difference nears statistical significance (contingency test, $\chi^2 = 3.818$, $df = 1$, $P = 0.0507$). On the second day, 11 of 19 females with eggs were accompanied by at least one male. Only three females with hatchlings were located on day 2, and one was accompanied by a male; this did not differ significantly from females with eggs.

We compared spiders that were inside domes, associated with domes, and on prey-capture webs. The data on spiders from prey-capture webs came from a survey conducted in July 1996 (Johnson 1997; Johnson & Jakob in press). In that survey, the number and class (small juvenile, medium juvenile, adult female, adult male, and female with eggs or

Table 1.—Spiders within 15 cm of the domes of focal females on consecutive days.

	Day 1	Day 2
Females with eggs		
1 male	8	8
2 males	2	
1 male and 1 female with eggs	2	1
1 male and 1 female with new hatch	1	1
1 female, 1 male, 1 medium, and 2 small		1
1 small	3	2
None	*3*	*6*
Total webs with eggs	19	19
Females with hatchlings		
1 male and 1 female	1	
1 male, 1 female, and 1 small		1
None	*4*	*2*
Total webs with hatchlings	5	3

Table 2.—A comparison of the number of spiders in different sex and age categories that were on prey-capture (sheet) webs, those that were inside domes, and those that were associated with domes on day 1. Expected values are in parentheses. Differences are significant ($\chi^2 = 2173.8$, $df = 8$, $P < 0.0001$). Patterns for day 2 are similar ($\chi^2 = 2117.3$, $df = 8$, $P < 0.0001$). [1]Data from Johnson 1997; Johnson & Jakob in press.

	Sheet webs[1]	Inside domes	Associated with domes
Females with eggs or hatchlings	0 (23.4)	24 (0.3)	0 (0.3)
Females	657 (645.7)	0 (7.8)	4 (7.5)
Males	123 (135.8)	0 (1.6)	16 (1.6)
Medium juveniles	763 (745.3)	0 (9.0)	0 (8.6)
Small juveniles	439 (431.8)	0 (5.2)	3 (5.0)

hatchlings) of all spiders on 1406 webs were recorded. Methods followed Jakob (1991), and included touching a ringing tuning fork to the web to attract spiders that might be hidden by vegetation at the web edge.

We found significant differences in the classes of spiders that were most likely to be found on prey-capture webs, inside domes, or associated with domes (Table 2). Dome webs contained more females with eggs or hatchlings than expected. Associates of domes were significantly more likely to be adult males than expected. As a follow-up test, we also compared dome associates only to spiders on prey-capture sheets, omitting females with eggs or hatchlings. Again, we found a significantly greater proportion of males associated with domes than on prey-capture webs (day 1: $\chi^2 = 143.1$, $df = 3$, $P < 0.0001$; day 2: $\chi^2 = 92.3$, $df = 3$, $P < 0.0001$).

Females with eggs and females with hatchlings behaved differently in response to the tuning fork ($\chi^2 = 18.24$, $df = 1$, $P < 0.0001$, Table 3). Females with eggs never exhibited predatory behavior, but instead gave no response or bounced. Four of five females with hatchlings attempted to wrap the tuning fork tip. These data suggest that the prey-capture response of the females is suppressed while she is holding eggs in her chelicerae, but returns when the eggs have hatched. Associated male and juvenile spiders also frequently attacked the tuning fork (Table 3).

Our data suggest that male spiders may be attracted to females in dome webs, particularly females carrying egg sacs. It is not known whether males are seeking to capture prey by using the dome web, seeking protection from predators by associating with females in domes, or seeking to copulate with the females. The first possibility seems unlikely as we never saw prey in these small webs. The second possibility is difficult to evaluate, given the lack of evidence of predation in this population. It seems most likely that males are seeking copulations with females: *H. pluchei* exhibits last-male sperm priority (Kaster & Jakob 1997), so a female that has already been mated would still be valuable to a male. It is not clear why juvenile or female spiders are

Table 3.—Responses of focal spiders in dome webs ($n = 24$) and associated spiders outside of dome ($n = 23$) webs to a ringing tuning fork.

	No response or slight movement	Bounce	Approach tuning fork	Wrap tuning fork
Focal female with eggs	15	4		
Focal female with hatchlings		1		4
Associated male	2	6	4	4
Associated female	1			
Associated female with eggs	1	1		
Associated female with hatchlings	1			
Juvenile			3	

found near domes and not on prey-capture webs. Our data from two consecutive days suggests that movements of associated spiders are not uncommon.

To our knowledge, special webs that surround the female and her egg case have not been previously described, although special webs built for spiderlings are known. Females of several species in the Pisauridae carry their egg until it hatches, build a special "nursery-web" for the spiderlings, and then guard them (reviews in D'Andrea 1987, Buskirk 1982). Feeding by the female is suppressed during guarding (Rabaud 1936, cited in D'Andrea 1987). Similar webs and guarding behavior have been reported in the Oxyopidae (Gertsch 1979).

Two functions of the dome web are likely. First, the dome web serves as a place from which spiderlings may hang during molting. In the laboratory, first-instar spiderlings removed from their dome webs and housed alone do not produce a web and subsequently die during their first molt. A second function that may have more bearing on the unusual shape of the web is an anti-predator function: by surrounding herself and her brood with silk, females may be able to sense vibrations of approaching predators more readily. Protection from predators is one of the proposed functions of maternal guarding in spiders (reviewed in Fink 1987), and guarding has been shown to significantly reduce predation on egg sacs in the green lynx spider (Fink 1986, 1987; Willey & Adler 1989). At this time, we are unable to assess this hypothesis for *H. pluchei* because the severity of interspecific predation pressure in either California or in its native habitat is not known. However, cannibalism is quite common in the California populations (EMJ pers. obs.), and it is possible that dome webs function to reduce cannibalism on hatchlings.

ACKNOWLEDGMENTS

We thank the National Science Foundation for support (IBN 94–07357 and IBN 95–07417), especially for a Research Experience for Undergraduates supplement that funded the fieldwork of KAS. A. Porter, S. Vessey, G. Stratton and A. Rypstra provided valuable comments on the manuscript. Thanks to E. Tani for photographic assistance.

LITERATURE CITED

Briceño, R. 1985. Sticky balls in webs of the spider *Modisimus* sp. (Araneae, Pholcidae). J. Arachnol., 13:267–269.

Buskirk, R.E. 1982. Sociality in the Arachnida. Pp. 282–367. *In* Social Insects, Vol. II. (H.R. Hermann, ed.). Academic Press, New York.

D'Andrea, M. 1987. Social behaviour in spiders (Arachnida, Aranea). Italian J. Zool., Monogr. 3.

Fink, L.S. 1986. Costs and benefits of maternal behaviour in the green lynx spider (Oxyopidae, *Peucetia viridans*). Anim. Behav., 34:1051–1060.

Fink, L.S. 1987. Green lynx spider egg sacs: sources of mortality and the function of female guarding (Araneae, Oxyopidae). J. Arachnol., 15: 231–239.

Gertsch, W.J. 1979. American Spiders. Van Nostrand Reinhold Company, New York.

Jackson, R.R., E.M. Jakob, M.B. Willey & G.E. Campbell. 1993. Anti-predator defences of a web-building spider, *Holocnemus pluchei* (Araneae, Pholcidae). J. Zool. London, 229:347–352.

Jakob, E.M. 1991. Costs and benefits of group living for pholcid spiderlings: Losing food, saving silk. Anim. Behav., 41:711–722.

Jakob, E.M. 1994. Contests over prey by group-living pholcids (*Holocnemus pluchei*). J. Arachnol., 22:39–45.

Johnson, S.A. 1997. Leg loss in male *Holocnemus pluchei*: What are the costs? Master's thesis, Bowling Green State University.

Johnson, S.A. & E. Jakob. In press. Leg loss in a spider has minimal costs in competitive ability and development. Anim. Behav.

Kaster, J. & E.M. Jakob. 1997. Last-male sperm priority in a haplogyne spider: Correlations between female morphology and patterns of sperm usage. Ann. Entomol. Soc. America, 90:254–259.

Nentwig, W. & S. Heimer. 1987. Ecological aspects of spider webs. Pp. 211–225. *In* Ecophysiology of Spiders. (W. Nentwig, ed.). Springer-Verlag, Berlin.

Rabaud, E. 1936. Notes sur le comportement maternel de *Pisaura mirabilis.* Livre jubil. Bouvier, Paris, 93–96.

Willey, M.B. & P.H. Adler. 1989. Biology of *Peucetia viridans* (Araneae, Oxyopidae) in South Carolina, with special reference to predation and maternal care. J. Arachnol., 17:275–284.

Kris A. Sedey and **Elizabeth M. Jakob**[1]: Department of Biological Sciences, Bowling Green State University, Bowling Green, Ohio 43403 USA

Manuscript received 20 December 1997, revised 10 June 1998.

[1] Current address: Department of Entomology, University of Massachusetts, Amherst, Massachusetts 01003 USA.